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Enhancing aerodynamic efficiency of golf ball by employing various dimple designs

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Progress in the field of fluid dynamics has unveiled various factors involved in flight of sports balls. Reverse swing of a cricket ball and Magnus effect on a curving and spinning football and tennis balls; clearly, accentuate the role of fluid dynamics. Golf ball aerodynamics on the other hand is significantly multifaceted than many other sports balls and is still not fully understood in spite of considerable amount of published data. Presence of small dimples over the surface enhances the intricacy level of airflow. These small dimples provide surface roughness and drag reduction as compared to a smooth sphere of same size. Varying geometry, size, pattern and shape of these dimples generate complex aerodynamic flow patterns. Davies (1949) analyzed aerodynamic forces on golf ball by dropping spinning balls through horizontal wind stream and concluded that dimpled surface gives greater distance and better control as compared to smooth golf ball. Further advancements led to the development of wind tunnel technique by Bearman and Harvey (1976) and subsequent measurements of aerodynamic forces that act on a golf ball with varying dimple geometries for a wide range of Reynolds numbers and spin rates. Profound inferences were drawn pertaining to delay of boundary layer separation and its impact on overall drag reduction. These two are the pioneer contributions to the aerodynamics of golf ball. In this review work, it is aimed to comparatively evaluate the drag reduction phenomenon by golf ball dimples. Recent major accomplishments involving computational analysis of separated and turbulent flows around a golf ball, local flow separations and shear layer instability around the dimples, influence of dimples with varying characteristics (configuration and geometry), comparative review of available golf balls, along with experimental evaluations of golf ball aerodynamic characteristics (Wind tunnel, smoke visualization and PIVs) are presented and thoroughly discussed in this article. Dimples characteristics such as shape, sizes and suitable numbers continue to be an active area of research because the results thereof affect the assertions, sales and the performance of different commercially available golf balls. A model golf ball with optimal aerodynamic characteristics is presented in the article.

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